B. Sc. Part II

Paper IV

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Current Electricity

Date

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Paper IV

Physics Hons

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Current electricity.

Mutual Inductance of Coefficient of Mutual Induction :-

Let two coil P (Primary) and S (Secondary) in which a current i in P Produce a magnetic flux ϕ_B in each turn of S. N_s be the total number of turns in S, Then the number of flux linkages through S is $N_s \phi_B$. For two given coils situated in fixed relative position, the flux linkage through the secondary is proportional to the current i in the Primary. Thus

$$N_s \phi_B \propto i$$

or $$N_s \phi_B = Mi$$

where M is a constant called the Mutual inductance of the coils.

This gives

$$M = \frac{N_s \phi_B}{i} \quad \text{---------} \quad (1)$$

The e.m.f. induced in S is given by

$$E = -\frac{d(N_s \phi_B)}{dt}$$

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But, $N\Phi_B = Mi$

$\therefore E = \frac{d}{dt}(Mi) = -M\frac{di}{dt}$

This gives

$$M = -\frac{E}{di/dt} \quad \text{---------- (2)}$$

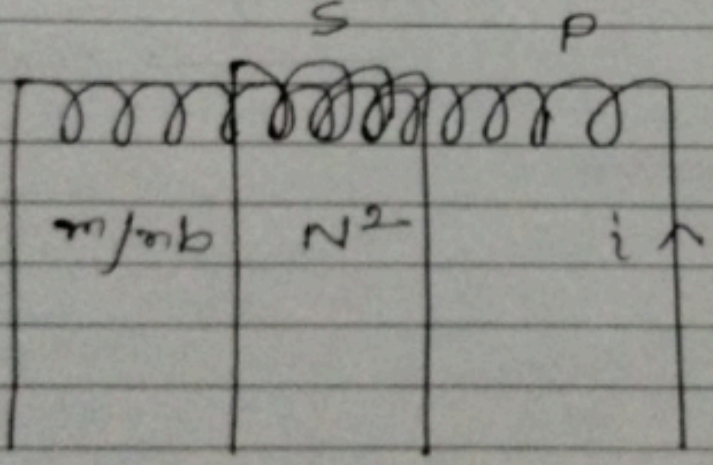
The equation (1) and (2) enable to define the Mutual inductance in the following two ways —

1) The Mutual inductance of two coils or circuits is numerically equal to the Magnetic flux linkages through one coil or circuit when unit current flows through the other.

2.) The Mutual inductance of two coils or circuits is numerically equal to the e.m.f. in one coil or circuit when the rate of change of current in the other is unity. Its units is also Henry.

Mutual Inductance Between two Co-axial Solenoids :-

Let a long air cored Solenoid as Primary coil of area of cross-section $A\ m^2$ and having n_1 turns per metre length of the Solenoid. A short 2nd Solenoid. As Secondary coil S of N_2 turns is wound closely over the central portion of the Primary P as shown in figure.



Let a current of i ampere be flowing in the Primary.

Then the Magnetic filed inside the Primary is

$$B = \mu_0 n_1 i \text{ wb/m}^2$$

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∴ Magnetic flux through each turn of the primary

$$\Phi_B = BA = \mu_0 n_p i A \quad \text{Weber}$$

Since the secondary is wound closely over the central portion of the primary, the same flux is also linked with each turn of the secondary.

$$N_s \Phi_B = \mu_0 n_p N_s i A \quad \text{Weber turns.}$$

By definition the Mutual inductance of the two coils is given by

$$M = \frac{N_s \Phi_B}{i} = \mu_0 N_p N_s A.$$

henry.